BOOKS RECEIVED

TRAITÉ D'EMBRYOLOGIE DES VERTÉBRÉS, par A. Brachet, Professeur à l'Université de Bruxelles: xv + 602 pp., 567 figures; Paris, Masson et Cie., 1921.—At present, the standard French text-book of embryology. The author states that its plan is wholly different from that of corresponding texts in Germany, England, and the United States; and its purpose is in fact quite unlike that of the Minot and Prentiss-Arey laboratory manuals, and of Bryce's or Keith's English works. It perhaps most resembles Hertwig's Lehrbuch. The general part, devoted to the first phases of ontogenetic evolution of the vertebrates and to the establishment of the great fundamental laws on which they depend, has, according to the author's preface, been developed in a manner befitting the importance of the subject, but chapters which are scarcely more than introductory to the study of histology or comparative anatomy have been somewhat summarily written. "A career long devoted to comparative embryology" has enabled Professor Brachet "to observe for himself many things and to arrive at personal opinions on many questions," the results of which appear throughout the book. The numerous figures have been well reproduced, and the paper and printing are good, despite the difficulties of "the present hour."

CAPITA ZOOLOGICA: VERHANDELINGEN OP SYSTEMATISCH-ZOOLOGISCH GEBIED, onder redactie van Prof. Dr. E. D. Van Oort, Directeur van 'S Rijks Museum van Natuurlijke Historie Te Leiden. Deel I, Aflevering 1, Dr. J. G. De Man—Nouvelles Recherches Sur Les Nematodes Libres Terricoles; (62 pages, 10 x 13, 14 plates). Deel I, Aflevering 2, Dr. G. Stiasny—Studien über Rhizostomeen, (180 pages, 5 plates): 's Gravenhage, Martinus Nijhoff, 1921.

A new Dutch zoölogical periodical is being published (The Hague) in the English, French and German languages. It includes transactions on systematic-zoölogical subjects, each number forming a complete work. The issues are sold separately. A volume contains about 500 pages including illustrations. The above described two numbers were issued in 1921.

LABORATORY APPARATUS AND REAGENTS Selected for Laboratories of Chemistry, Metallurgy and Biology in their application to Education, The Industries, Medicine and the Public Service, 8 x 11¼, 620 pages, profusely illustrated; with additional matter consisting of Code Index and Condensed Price List, 72 pages; Reagents for analysis, Bacteriology, Microscopy and Metallurgy, 104 pages and a 20 page Index; Philadelphia, Arthur H. Thomas Company, 1921.

This new edition of the Catalogue in stiff cloth cover not only has ample and exact descriptive text, with full reference to scientific publications involved and methods of use (where such are likely to be of interest) and accurate illustrations as in previous editions, but also contains several new features; actual prices (other than daily market changes), contents of original packages, Code Index giving code word for each size of every item listed, and Reagent listing with code word for every size of original package, explanation of export terms, preparation of documents and method of packing for export. The printing, papers used, and binding are excellent.

(*Continued on page 322*)

Resumen por el autor, Paul H. Stevenson.

Sobre un músculo digástrico anómalo en el muslo de un chino.

En el presente trabajo se da a conocer una observación sobre la presencia de dos vientres musculares supernumerarios unidos con los músculos biceps y piriforme del fémur, respectivamente, y contínous entre sí mediante un tendon intermediario asociado con la fascia que se extiende sobre el gran trocánter. Las relaciones de los músculos con las estructuras vecinas, así como las relaciones que presentan entre sí, indican la existencia de una sola anormalidad del desarrollo, la cual produce un músculo de forma digástrica, en vez de dos músculos aberrantes separados que se reunen después de su llegada a un punto común anormal. El autor revisa las relaciones embriológicas tempranas de la región, y aquellos estados de la diferenciación de los esbozos musculares tempranos que tienen importancia en la anomalía descrita son objeto de discusión. En adición a la anomalía objeto del presente trabajo el autor enumera otras siete anomalías observadas en los músculos apendiculares y en los nervios del mismo sujeto.

Translation by José F. Nonidez
Cornell University Medical College, N. Y.

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, MARCH 27

ON AN ANOMALOUS DIGASTRIC MUSCLE IN THE THIGH OF A CHINESE

PAUL H. STEVENSON

Anatomical Laboratory of the Peking Union Medical College

ONE FIGURE

Failure to find in the literature any citation of the following variations in the musculature of the lower extremity suggests the value of placing the present case on record. From the standpoint of ontogeny, the relations found present a picture of such unusual interest that a brief discussion of the developmental factors concerned is also included in this report.

DESCRIPTION

The anomalies to be described represent the most important of several observed during the dissection of a male Chinese, age 39. An enumeration of the other abnormalities observed in this same body is appended at the end of this report.

Lying beneath the long head of the biceps femoris and roughly bisecting the angle between that and the short head, there was discovered a third distinct, though smaller head to this muscle. The fibers of this supernumerary muscle slip, which measured approximately 15 cm. in length and from 3 to 5 cm. in diameter, converged proximally into a small tendon which passed out of sight in the earlier stages of the dissection between the peroneal and tibial divisions of the sciatic nerve (fig. 1). At the same time there was observed a smaller cord-like tendon emerging from beneath the lower border of the glutaeus maximus above and passing distomedially toward the deeper structures of this region of the posterior thigh. Although the course of this latter tendon formed a distinct angle with that of the tendon arising immediately from the supernumerary head of the biceps, yet

manipulation and subsequent dissection proved their continuity one with the other. In brief, the tendon of this anomalous muscle, continuing proximally from the distodorsal position of

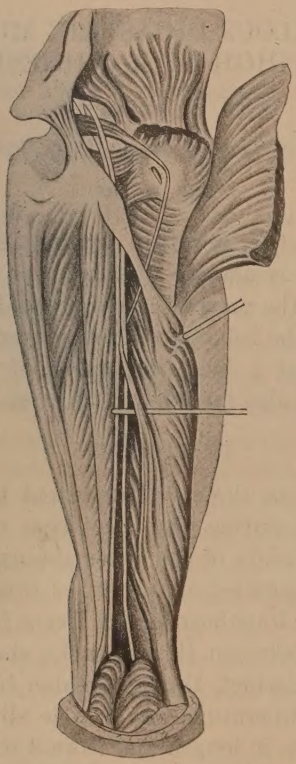


Fig. 1 A semidiagrammatic drawing of the posterior musculature of the thigh in which the anomalous digastric muscle appeared, showing the relations of the two muscle bellies to the piriformis and the biceps, respectively, as well as the relation of the intervening tendon to the peroneal division of the sciatic nerve and to the greater trochanter.

the muscle below, passed dorsoventrally around the medial side of the peroneal nerve and, after becoming loosely associated with the fibrous tissue investing the divided sciatic nerve, changed its course from a slightly medial to a slightly lateral direction (fig. 1).

Upon reflecting the glutaeus maximus muscle and tracing the proximal portion of this anomalous tendon to its origin, it was observed to be associated with the capsule of the bursa lying between the glutaeus maximus and the greater trochanter (b. trochanterica m. glutaei maximi).

Careful dissection of the origin of the above tendon and examination of the relation of its fibers to those of the superficial layer of the bursa capsule revealed the fact that the tendon did not end there. Although sending out several diverging strands of fibers which became intimately incorporated in the capsular connective tissue, the tendon itself remained more or less distinct from the structure of the capsule and continued across it as a conspicuous though slightly flattened band (fig. 1).

The subsequent course of the tendon after leaving the surface of the bursa capsule at its proximomedial border was directed strongly medialward. The tendon now ran roughly parallel to the lower border of the piriformis muscle, being separated from the latter by a well-defined space of from 1.5 to 2 cm. above as well as by an interval corresponding to the thickness of the dorsal margin of the greater trochanter ventrally. In the case of the left side this tendon remained a fibrous cord throughout the rest of its course. On the right side, however, the tendon served as the attachment of a small muscle slip, from 1 to 3 cm. wide and approximately 10 cm. long, which passed ventral to the peroneal nerve and then between this and the tibial nerve as these emerged as separate nerve trunks from the pelvis, thereby duplicating in respect to the peroneal nerve the relations of the distal portion of the tendon below the capsule (v. supra). This proximal muscle slip continued medially to its origin on the anterior aspect of the third and fourth sacral vertebrae and from the dorsolateral surface of the sacrospinous ligament.

These two aberrant muscle slips were innervated by a twig from the tibial and a small branch of the anterior division of the second sacral nerve, respectively.

DISCUSSION

The embryological interpretation of the anomalous condition just described is not at once obvious. A brief discussion of some of the more relevant factors involved may therefore be considered not out of place.

In the first place, it may readily be suggested that we are dealing simply with two aberrant muscle slips—arising from two well-defined muscle entities, viz., the biceps femoris and piriformis muscles, known in each case not infrequently to give rise to supernumerary slips—whose tendons have secondarily become associated with each other in the connective tissue overlying the greater trochanter as described above. Testut,[9] Schaeffer,[8] Frohse and Fränkel,[5] LeDouble,[7] and others have not only reported original cases, but have compiled long lists of supernumerary heads and aberrant slips observed in connection with the biceps femoris. To them the reader is referred for a detailed enumeration of these cases. When these reports are closely analyzed, however, and due allowance made for differences in terminology and interpretations, it is found that the range in variation in the origin and insertion of such slips is not wide. Testut (l.c., p. 993) summarizes the eight or nine distinctive types reported in the literature up to 1911 as follows:

"Le muscle biceps peut être renforcé par des faisceaux surnuméraires, provenant suivant les cas: 1° du condyle externe (Gruber); 2° de la partie supérieure de la ligne âpre (Meckel); 3° de la ligne rugueuse qui réunit le grand trochanter à la ligne âpre (Giacomini); 4° du fascia lata (Henle); 5° du vaste externe; 6° du grand adducteur.—J'ai observé chez un nègre (Dissection d'un Boschiman, in Arch. du Muséum, 1885), un faisceau surnuméraire, de forme triangulaire, qui partait du coccyx pour aller grossir la masse commune du biceps et du demi-tendineux.—Turner a signalé (Jour. of Anat. and Phys., 1872), sous le nom de tensor fasciae poplitealis, un petit faisceau musculaire qui se rendait du biceps à l'aponévrose poplitée.—Des faisceaux plus singuliers encore, se rendant du biceps au tendon d'Achille et au calcanéum, ont été observés par Kelch (Beitr. z. path. Anat., 1813), par Gruber (Beobacht. aus d. menschl. u. vergl. Anatomie, Heft. II, Berlin, 1879) et par Halliburton (Jour. of Anat. and Phys., 1881).[9]

Careful reading of the original of as many of the above references as were available, not only for the particular variation reported in each, but also for the review of such supernumerary slips of the biceps femoris in general that is usually contained in these writings, failed to reveal, however, any record of such an aberrant head taking origin from the fascia (either entering into the formation of the bursa capsule or otherwise) over the greater trochanter. Of the possible exceptions to this, the cases of the Giacomini and of Henle quoted by Testut (v. supra) seem to refer in the first instance to a definite bony origin from a line on the femur between the greater trochanter and the linea aspera, evidently a slip from the short head of the biceps having an independent origin slightly proximal to the usual origin of that head on the linea aspera, and in the second instance to a more superficial fascial slip from the fascia lata to the long head of the muscle. LeDouble (l.c., p. 281) also mentions a supernumerary fascial attachment "de la face profonde du grand fessier, à quelques centimètres de ses insertions iliaques" which, although associated with the fascia of the deep surface of the glutaeus maximus, seems to be distinct from the instance herewith reported.

The second muscle slip with which we are concerned in the present view of the anomaly is the proximal fleshy termination of this aberrant tendon. Continuing medially and proximally from the trochanter and passing ventral to the peroneal nerve and then dorsally between it and the tibial nerve trunk to its final origin from the sacrum, this muscle slip would probably be considered in such a scheme simply as a divided portion of the piriformis. Both in point of origin and in its relation to the two divisions of the sciatic nerve this muscle slip qualifies well for such a classification, and the condition, if indeed this is the condition with which we are dealing, is found frequently enough to warrant the statement that it occurs normally in about 20 per cent of all cases.[4] Such divisions affect only the proximal portion of the muscle, however, and almost invariably reunite with the main piriformis muscle tendon to become inserted with it upon the anterior and inner portion of the upper margin of the

greater trochanter. A complete separation of such slips from the usual fibers of the piriformis at the point of their insertion, on the other hand, and a subsequent migration of their insertion from the inner aspect of the trochanter downward and outward to a position on the lateral side of the trochanter, as apparently has occurred in the present case, has never been noted in the literature as far as the writer has been able to ascertain. Upon the occurrence of a continuation of such an aberrant tendon from the piriformis with an equally aberrant tendon which has reached the same point from the biceps femoris below, the literature is similarly silent. The difficulties in the way of supplying this latter phenomenon with a logical developmental background are obvious.

The second view of the anomalous condition as observed in this case suggests that we are dealing with a single developmental anomaly resulting in a compound muscle of digastric form. The early work of Bardeen and Lewis[1] and the later studies of the former[3] leave little doubt that the anlages of such muscle aberrancies as those with which we are here dealing become differentiated as such, either during or very soon after the period of general differentiation of muscle groups within the primitive myogenous zone of the limb. Unfortunately, none of the excellent figures in the articles just referred to were drawn from an angle showing the respective anlages of both the biceps femoris and the piriformis at the same time. A careful study of these figures of actual reconstructions of the developing nerves and muscle of the lower limbs in very early human embryos, however, gives good evidence of two facts having a direct bearing on the possible formation of the anomaly in question.

In the first place, in the still undifferentiated myogenous zone of the limb bud up to the 7- or 10-mm. stage, those concentrating areas of cells which are destined to differentiate later as the specific anlages of the biceps and piriformis muscles lie very close together. The only structure intervening in the following stages of progressive differentiation in this region is the outgrowing sciatic nerve trunk. This means that in those cases where the sciatic nerve, either as a whole or in part, pierces the piriformis

muscle a portion of the anlage of this muscle is still less definitely separated from that of the biceps which lies immediately adjacent. Such a split-off portion of the piriformis anlage, as mentioned above, almost invariably again associates itself with the main body of the muscle to become incorporated in the common tendon of insertion, after transmitting a portion or all of the sciatic nerve through the resulting proximal hiatus. Failure to reunite with its parent anlage, however, would present the alternative possibilities either of an independent existence or of an association with a neighboring muscle anlage. Both of these fates of aberrant slips from the piriformis are apparently rare in man, but that such an association with the adjacent biceps sometimes occurs in the case of lower forms may account for the original opinion of Gegenbaur[6] (since corrected by later observers), that the piriformis was derived from the caudofemoral muscle of urodeles—a muscle represented in many mammals by a caudofemoralis extending from the caudal vertebrae to the lateral side of the distal half of the femur.[2] The writer believes that the present case represents an example of such an association between a separated portion of the piriformis anlage and that of the biceps femoris in man. The picture in this case is somewhat complicated by an intervening attachment over the greater trochanter, which will be discussed below, but it is altogether probable that the case of a sacral attachment of the biceps attributed to Macalister (original reference not given) by LeDouble (l.c., p. 281) represents an uncomplicated case of such an embryonic association between these respective muscle anlages.*

The second relevant fact derived from a study of the reconstructions of early human embryos referred to above is the relations of the developing skeletal elements in the primitive scleroblastema with reference to the two muscle anlages dis-

* The sacral attachment of the biceps here under discussion must not be confused with the frequent fasciculi from the coccyx, sacrum, or sacrotuberous ligament to the long head of the biceps, giving rise to the opinion of some investigators that the long head of the biceps represents a muscle primitively arising from the sacrum or coccyx and that the sacrotuberous ligament represents a transformation of that part of the muscle originally extending between the sacrum and its present origin from the ischial tuberosity.

cussed in the preceding paragraph. These are more clearly emphasized in the further studies of Bardeen devoted entirely to the development of the human skeleton. Up until a stage of development represented by a 14-mm. embryo (embryo CXLIV, pl. III, figs. 5 and 6, Bardeen[2]), or considerably after the beginning of the muscle-anlage differentiation, the developing femur has maintained its primitive position in relation to the pelvis. At this time the shaft of the femur lies approximately at right angles to the body axis and extends directly into the hip-joint. Here there is no neck, merely a simple rounded head, distal and dorsal to which a slight projection marks the beginning of the greater trochanter. Thus the primitive anlage of the trochanter lies not only in direct line, but also practically in the same plane with the two muscle anlages discussed above. The possibility of a secondary association between the aberrant muscle-slip anlage herewith implied and the developing trochanter lying immediately ventral to it would be enhanced in the case in question by the tendency naturally inherent in any divided portion of the piriformis to seek an attachment on the trochanter.

By the time the development of the embryo has progressed to a stage represented by one of 20 mm. (embryo XXII, pl. IV, figs. 9 and 10, Bardeen[2]), the trochanter is not only clearly differentiated as such, but has also rotated lateralward from its more primitive position. This lateral rotation and subsequent shifting of the trochanteric region incident upon the progressive development of the future conformation of the proximal end of the femur, dragging with it the blastemal attachments already formed—which in the case in question would include that of the aberrant muscle anlage bridging the gap from the piriformis above to the biceps below—would account for the picture presented in adult life (fig. 1).

The writer is led to suggest this second interpretation, therefore, as the true explanation of the appearance of this muscle of digastric form in the musculature of the posterior region of the thigh of this Chinese subject. Rather than with two aberrant muscle slips arising independently from distinct and widely separated muscle entities, effecting a unique union after pursuing

courses equally unusual, it seems more probable that we are dealing with the development of a single muscle anlage, the central and later tendinous portion of which early became associated with an adjacent skeletal element whose subsequent rotation from its primitive position obscures somewhat the fact of the essential continuity of the widely separate muscle bellies.

In addition to the anomaly reported above, the following were also observed in this same subject: 1) excessive size of the peroneus tertius muscle in both legs; 2) absence of the tendon of the flexor digitorum brevis usually passing to the little toe; 3) supernumerary slip arising from the tendon of the flexor digitorum longus beneath the laciniate ligament and dividing into two tendons inserting into the lateral side of the flexor digitorum brevis and the second phalanx of the fifth toe, respectively; 4) total absence of the plantaris muscle on the left side and its reduction to a fibrous cord on the right; 5) the anterior trunk of the seventh cervical nerve joins that of the eighth to form the medial cord of the left brachial plexus, while on the right side the anterior trunk of this same nerve divides into two divisions of approximately equal size joining the lateral and medial cords of the plexus, respectively; 6) supernumerary heads of both biceps brachii arising in each case from the middle third of the medial side of the humerus; 7) a small aberrant muscle slip in the right forearm, having its origin in common with the flexor digitorum sublimis and becoming tendinous soon after its origin and passing down the arm and beneath the transverse carpal ligament as a slender tendinous cord which inserted in the palm into the tendon of the flexor digitorum profundus passing to the third finger.

LITERATURE CITED

1 Bardeen, C. R., and Lewis, W. H. 1901 Development of the back, body wall, and limbs in man. Am. Jour. Anat., vol. 1, pp. 1–36.

2 Bardeen, C. R. 1905 Studies of the development of the human skeleton. Am. Jour. Anat., vol. 4, pp. 265–302.

3 1907 Development and variation of the nerves and musculature of the inferior extremity and of the neighboring regions of the trunk in man. Am. Jour. Anat., vol. 6, pp. 259–390.

4 1921 Morris' Human Anatomy, 6th ed., p. 493. Blakiston.

5 Frohse, F., and Fränkel, M. 1913 Die Muskeln des menschlichen Beines, v. Bardeleben Handbuch d. Anat. d. Mensch., 2 Bd., 2. Abt., 2. Teil, S. 536, 649.

6 Gegenbaur, C. 1898 Vergleichende Anatomie der Wirbelthiere, Bd. 1., S. 696. Leipzig.

7 LeDouble, A. F. 1897 Traité des variations du système musculaire de l'homme, T. 2, p. 280. Paris.

8 Schaeffer, J. Parsons 1913 On two muscle anomalies of the lower extremity. Anat. Rec., vol. 7, pp. 1–8.

9 Testut, Leo 1911 Traité d'Anatomie Humaine, T. 1, p. 993. Paris.

Resumen por el autor, C. Judson Herrick.

Algunos factores en el desarrollo del sistema nervioso de los anfibios.

El autor considera tres aspectos del problema del orígen y desarrollo del sistema nervioso, a saber: 1) Los factores hereditarios de orígen muy remoto, tales como el metamerismo primitivo; 2) Los factores hereditarios de orígen mas reciente, de significación adaptativa evidente, tales como los patrones de reflejos; 3) El efecto inmediato de la función activa sobre el progreso del desarrollo individual.

En la investigación de los factores segundo y tercero es necesario primeramente descubrir qué representan estas adaptaciones funcionales y como están estructuralmente representadas en el cerebro. La localizacion anatómica de los sistemas funcionales específicos del cerebro del Amblystoma adulto ha sido determinada y este patrón anatómico puede seguirse hacia atrás en la serie embriológica hasta los estados tempranos. La correlación de la estructura de estos estados del desarrollo con los tipos de reacción de especies individuales es al presente objeto de investigaciones. Después se determinen de este modo estos factores funcionales adaptativos en la morfogénesis, el análisis ulterior del proceso del desarrollo mediante métodos experimentales y de otra clase puede llevarse a cabo con mayor facilidad. En el presente trabajo se ha incluído un resumen de los trabajos más recientes sobre el sistema nervioso de Amblystoma, así como indicaciones para la investigación cooperativa.

Translation by José F. Nonidez
Cornell University Medical College, N. Y.

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, APRIL 17

SOME FACTORS IN THE DEVELOPMENT OF THE AMPHIBIAN NERVOUS SYSTEM

C. JUDSON HERRICK[1]

Anatomical Laboratory, The University of Chicago

Three factors, amongst others, may be recognized in the embryologic development of the brain:

1. Very ancient palingenetic hereditary influences, such as primitive metamerism. These doubtless originally had functional significance, but this is now largely lost and these vestigial features are in most cases masked or suppressed early in developmental history.

2. Obviously adaptive features which are firmly hereditary but of relatively recent (cenogenetic) origin, e.g., reflex patterns and their neuromotor apparatus.

3. The immediate effect of active function upon the progress of individual development—facilitation by use, trophic response of the tissue to excitation, direct action of physiologic gradients of excitation and conduction upon direction and rate of growth (Child, '21), the bioelectric phenomena of excitation and differentiation and their directive influence upon contiguous differentiating neuroblasts (Lillie, '19; Kappers, '17, '21; Bok, '15, '17; Ingvar, '20), hormone action, and probably many others. Some of these are critically discussed by Child ('21).

Students of the embryology of the brain have been inclined to stress the first of these factors, to touch lightly upon the second, and to dismiss the third as irrelevant to their studies. Recent years, however, have seen a notable change brought about largely

[1] This summary has been written up in collaboration with a number of active students of amphibian development, and it seems to us that its publication at this time would serve a useful purpose in promoting more effective integration of efforts now somewhat dispersed among scattered workers by directing attention to certain features of these researches which look toward problems of more general significance.

by improvement in the technical methods of experimental analysis of the problem, and the demand now is for coördinated attack upon the problems of development on all these frontiers.

To learn the rôle of functional adaptations of the second and third types, obviously it is first necessary to determine what these adaptations are. As applied to the development of the central nervous system, this implies a more complete knowledge of the functional localization and functional interrelationships of parts than we possess at present for any animal except man—and even here our ignorance is more extensive than our knowledge. The inconceivable complexity of the human brain is a serious obstacle to such an analysis and, moreover, the mammalian nervous system does not readily submit itself to the methods of experimental embryology.

The amphibian nervous system is free from the two objections just mentioned and in addition it has the further advantage that it begins to function in response to external stimulation at a surprisingly early stage of development. Complex adaptive reflex mechanisms which in the human nervous system attain full structural maturity before they are called upon to act at all can in a series of young amphibian tadpoles be observed in function at progressively advancing stages from the simplest beginnings to very complicated definitive forms, and the structures which are added from stage to stage of the increasingly complex reflex pattern can be identified and correlated with the specific parts which they have to play in the total physiologic complex.

Intensive studies of the development of Amblystoma, both observational and experimental, have been in process for a long time. Coghill has observed the earliest reactions of urodele larvae to external stimuli and determined the sequence of progressively more complex behavior patterns. These observations were first made on Diemyctylus ('09) and have since been extended to Amblystoma. The earliest reactions of these larvae to contacts on the head and trunk are of three types, but all immediately or within a few hours come to a form in which for from 48 to 96 hours the head is regularly moved away from the side touched, an avoiding reaction. This 'early flexure' stage is followed successively by

a series of stages leading up to the 'early swimming' stage. Later experiments on Amblystoma have shown that the 'early swimming stage' is followed by 'non-responsive' stages (to tactile stimuli around the mouth), and these by 'feeding' stages.

Coghill and his pupils have in progress an extensive study of the structural changes correlated with this sequence of clearly defined functional stages, some parts of which have been published ('13, '14, '16). The sequence of maturation of the elements of the neuromotor mechanism is found to present a very instructive parallelism with the demonstrated functional sequence and important contributions have been made to the question of the nature of the most primitive reflex mechanisms (cf. Herrick and Coghill, '15).

Mention should be made in this connection of the valuable studies made by Paton ('07) on various species of vertebrates which, though not parallel with Coghill's, were similarly directed, and of the still unpublished work of Dr. H. C. Tracy on the toadfish, Opsanus. Both of these include the study of spontaneous movements and also reactions to external stimulation. Tracy has already carried his study of the sequence of the development of the nervous system in correlation with observed behavior to an advanced position. While the details of the development of the reflex patterns of the toadfish are naturally very different from those of amphibians, yet there are some general principles of development common to the two which are very instructive, and the differences between the two species are not less so as illustrative of adaptive changes correlated with the long period during which the toadfish larva is firmly attached in a protected situation.

The present writer has attacked the problem from the opposite side and is engaged upon histological studies of the adult and late larval nervous systems of Amblystoma and other urodeles, taking as the point of departure Coghill's earlier ('02) analysis of the functional components of the peripheral nerves. The determination of the exact pathways between the peripheral end-organs and their cerebral centers has permitted an accurate mapping of the primary reflex centers of the brain—tactile, gustatory,

visual, olfactory, etc., and the various motor nuclei. Anatomical continuity between these end-organs and their respective cerebral centers gives a true indication of the functions of the latter. This has been adequately controlled physiologically. By an application of the same principle anatomical analysis of the complex central fiber tracts which connect these primary centers with each other and which connect them with their respective higher correlation centers yields definite information regarding the functions of the higher centers.

The ultimate court of appeal in searching for the precise localization of function in the nervous system is, of course, direct experimentation; but there are many regions of the central nervous system which are as yet inaccessible to such experimental studies, and the anatomical methods just mentioned under proper control are here very serviceable.

The brain of adult Amblystoma is very simply organized, with relatively little departure from the form of the early embryonic neural tube, except for the great flexures and the local thickenings of the wall produced by the various correlation centers to which reference has just been made. To these there is added in the forebrain a considerable outpouching or evagination of the entire wall on each side, thus producing two hollow cerebral hemispheres whose pattern is in fundamentals similar to that of the hemispheres of the human brain (cf. Herrick, '21).

Beginning with an analysis of the primary reflex centers of the medulla oblongata and their secondary connections in Amblystoma of mid-larval stages (Herrick, '14a), the higher connections of these secondary tracts and their relations to optic and olfactory centers have been determined. These studies are far advanced and, through the united labors of several neurohistologists, we have now a fairly complete knowledge of the functional pattern of the brains of Amblystoma and other urodeles. Among the more important contributions to this subject, mention may be made of papers by Kingsbury ('95), Herrick ('10, '14, '17, '21a), Röthig ('11, '11a, '12,), Bindewald ('14), Larsell ('20). The writer also has a considerable mass of observations as yet unpublished.

Notwithstanding the simplicity of external form of these urodele brains, the knowledge of the functional localization derived from studies of the fiber tracts permits the assignment of tolerably precise functional meanings to numerous external landmarks. In short, the reflex patterns as functional entities can be correlated with a mosaic of structural pattern, part of which is externally evident. The neurons of the correlation centers occupy more space than do the related fiber tracts. Accordingly, the location of these centers is indicated by the sculpturing of the external and ventricular surfaces of the brain.

The details of the ventricular structure of the brain of adult Amblystoma have not yet been published (for Necturus, see Herrick, '17), but these have been carefully charted and their functional connections determined. It is, therefore, possible to define each ventricular eminence and external landmark in terms of functional correlations there effected and to compare these with corresponding regions of the human brain so far as the latter are represented in the Amphibia.

The morphological analysis of the amphibian forebrain published by the writer in 1910 was based largely upon adult material. How far this will stand the test of further embryological and experimental control remains to be determined. It is evident that these conclusions, in so far as they may prove valid, are expressions chiefly, perhaps wholly, of the second and third types of process mentioned at the beginning of this sketch. As was recognized at that time, they are not derived from primitive metamerism, the longitudinal columns of His, or other palingenetic features of that category; but rather they represent later structural modifications superposed upon those ancient patterns.

The next step is to read this mosaic pattern backward into successively younger stages of the development of the brain, identifying each region by its superficial markings or internal fibrous connections or by both of these criteria. This is readily accomplished for each functionally defined area as far backward in the series as its functional fiber-tract connections are demonstrable.

It is found, as the series is followed forward from younger to older stages, that the invasion of a given undifferentiated area by a definite fiber tract arising in a remote part and conducting some specific functional type of nervous impulses is accompanied by a pulse of local differentiation. As the various fiber tracts of the forebrain successively mature and functional connections are made with different regions, there is an immediate structural response in the form of more rapid local proliferation of neuroblasts in the areas newly invaded by the growing fibers. This results first in a thickening of the wall in the differentiating areas on the ventricular side, followed in many cases either by corresponding thickening on the lateral surface or by a local bowing out or buckling of the entire wall producing an evagination.

This localized acceleration of growth can in some cases be correlated with a definite increment, on the side of behavior of the living tadpole, in the complexity of the reflex pattern. The pulse of local differentiation is, therefore, probably very largely of the third physiological type to which reference was made in the beginning, viz., a direct reaction of the embryonic tissue in question to excitation entering from without its own substance, or a true functional response. This excitation is not necessarily a functional response to the stimulation of an end-organ of adult type, but it may be a change in metabolic rate or bioelectric state produced locally by the ingrowth of new axons into indifferent embryonic tissue (cf. the experiments of Ingvar, '20, and the transplantation experiments of Burr, '20).

But it is possible to read this mosaic pattern of regions which in the adult are obviously functionally defined back to still younger stages in some cases, that is, these regions present recognizable morphological criteria at stages antecedent to the appearance of functional fiber-tract connections. Regions which in the adult are of high functional value, in prefunctional stages may exhibit an acceleration of growth resulting in various local thickenings and dilatations of the neural tube and the great flexures. This would seem to imply hereditary factors of the type characterized by Cope ('87, p. 126) as heterochronous accelerated development, to wit, the appearance of adaptive struc-

tures at a date earlier in the ontogeny than would be consonant with an exact recapitulation of the phylogeny. How far this type of differentiation is due to the actual inheritance of morphological pattern such that particular parts of the neural tube tend to unfold in a predetermined way through the action of resident forces, and how far this sequence of changes in a particular region is due to the present influence of morphogenetic factors acting upon it from its intraorganic environment, such as Child's gardients, hormones, etc., is an approachable problem.

An important first step would seem to be the determination of the exact functional pattern which in the final stage—the adult brain—is reflected in the structural mosaic of the definitive neural tube. A second step carries this mosaic pattern back to the earlier stages of the ontogeny as far as the functional factors of the adult type can be shown to be operative, that is, to the first appearance of the several fiber-tract connections of known functional significance.

After the morphogenetic influence of these factors is determined, the residual factors must be further analyzed, and here a variety of methods are available. Some of these methods are purely observational, some are experimental.

The embryology of the Amphibia has been much studied. The only detailed account of the early development of the nervous system of Amblystoma is that of Griggs ('10), though there are several good accounts of the formation of the neural tube and the earlier phases of its differentiation of other urodeles. No description of the later stages of the brain of Amblystoma has been published.

Landacre is investigating the cranial ganglia of urodeles and has published ('21) an important paper giving the history of the neural crest. He describes extensive contributions of cells from this and other ectodermal sources to mesodermic structures (formation of mesectoderm), and follows the history of some of these cells through to their ultimate differentiation into head cartilages. This commingling of cells of the same origin as those of the brain with the cells of entodermal mesenchyme in the formation of non-nervous organs of the head may play some rôle as yet

undetermined in the equilibrated systems of growth. The relations of the definitive cranial ganglia to the neural crest and of both of these to the neural tube on one hand, and to the general ectoderm, on the other hand, have been investigated by Landacre in a number of vertebrates, and further studies of these questions and of the formation of mesectoderm in Amphibia are in process. Coghill has published ('16) graphic reconstructions of the functional composition of the cranial ganglia and related sensory centers of the medulla oblongata of Amblystoma in four of his functionally defined stages.

The further prosecution of these embryological studies will contribute much of value in the analysis of the morphogenetic factors operative in the development of the nervous system of Amblystoma. We wish to know what was the primitive segmentation of the urodele head and the fate of these segments in the later development of the nervous system, what are the sources from which the various parts of the central and peripheral nervous system have drawn their building material (these apparently differ in closely allied species); what (if any) are the inherited potencies of these various kinds of material; to what extent and in what ways do excitations acting directly upon them shape the course of their development; and the evidence (if any) of the presence of inherited patterns of adaptive (cenogenetic) type in this development.

Evidently observational methods alone are incompetent to answer all of these questions, but observation must furnish the sound basis upon which crucial experimental tests can be devised. And it is indispensable that the observational studies and the experimental program be kept in the closest possible articulation. Coghill, for instance, is engaged upon a correlation of the growth rhythms of the central nervous system (as measured by the number and distribution of mitotic figures at successive stages of known physiological type) with those of various non-nervous organ systems. This may shed light upon the nature of the physiological equilibrium in the organism as a whole during the march of these events, and it would not be at all surprising if these observations would correlate in a fruitful way with studies on the morphogenetic influence of the ductless glands.

Experimental investigation of the interrelationships of the endocrine organs during development has already brought to light some surprising facts. As illustrations of these, mention may be made of the studies upon the Amphibian hypophysis of Allen ('16, '20) and P. E. Smith ('20). These exhibit the influence of an organ upon remote parts of the body through the agency of transported materials.

It has long been supposed that contiguous parts may exert a chemotactic or other influence upon the development of the nervous system, and the recent studies of the bioelectric phenomena of metabolism, and especially of excitation and conduction, to which reference has already been made, have suggested a possible mechanism for this type of reaction of the tissues. The investigation in the Amphibia of the physiological gradients to which Child has devoted so much attention has been begun by Bellamy ('19). He has studied the effects of various toxic and depressing agents upon the gradients in physiological activity along the axes of the embryo and the rôle of the normal physiological gradients as morphogenetic factors. Publication of further results of these experiments is promised, and it may confidently be expected that additional data of far-reaching importance in the analysis of the functional components in the complex history of the development of the nervous system will be brought out.

From the dawn of experimental embryology until now the Amphibia have presented most favorable materials for experiments in this field. Limitations of space here forbid reference to even the most important of these investigations, but it is generally recognized that this avenue offers a very direct approach to the problems centering about the relations of developmental factors intrinsic to an organ or tissue and those which are the expressions of extrinsic agents. In this country Amblystoma is a more satisfactory subject for many of these lines of inquiry than any other type. The genus is widely distributed, the eggs are easily collected and reared, and the larvae are hardy and favorable for operative work. The activities of Harrison's laboratories in recent years have given evidence of the peculiar fitness of this material for many lines of embryological study.

Burr in three recent studies ('16, '16 a, '20) has opened a fruitful line of investigation by a direct frontal attack upon the question of the relation between intrinsic and extrinsic factors in the morphogenesis of the cerebral hemispheres of Amblystoma. By an ingeniously planned series of experiments he has shown that the hemisphere develops under the influence of excitations entering at opposite ends, from the olfactory organ and the thalamus, respectively. The destruction of the nasal organ in prefunctional stages results in the failure of the rostral end of the hemisphere to complete its differentiation. The effect of cutting off all nervous impulses coming into the hemisphere from the thalamus was determined by transplanting the hemisphere, before the ingrowth of such fibers, into the skin of the side of the body. The olfactory placode was transplanted with the hemisphere and made connection with the brain in the normal way. The hemisphere developed to nearly normal size, but the parts normally directly connected with the diencephalon were retarded in development. No part was totally atrophied, in conformity with the well-known fact that practically all parts of this hemisphere receive fibers from the olfactory bulb, which was well developed. In one series of experiments the olfactory placode was transplanted to a superficial position so that (presumably) it was capable, in later stages, of normal peripheral stimulation; in another series the placode was buried beneath the skin so as to preclude stimulation from the exterior. The related transplanted hemispheres developed equally in the two cases, showing that the stimulus to differentiation of the olfactory centers is provided by the ingrowth of the olfactory fibers, even though these are never normally excited. It would be interesting to learn the effect of carrying the experiment further and transplanting the cerebral hemisphere alone without the olfactory placode, thus isolating it completely from any form of nervous excitations. This would show whether the primitive hemisphere vesicle has any capacity whatever for intrinsic differentiation beyond the stage normally reached when nerve fibers first penetrate it from adjacent parts.

In another series of experiments it was shown that extirpation of the hemispheres in prefunctional stages is followed by very

little regeneration in case the olfactory placode is also removed; but if the latter is left in place the hemisphere does regenerate to normal form under the influence of the ingrowing olfactory fibers.

Such experiments can be indefinitely multiplied, and it is very desirable that this should be done, and also that after such operations the larvae should be reared (in so far as they are viable) to a sufficiently advanced stage of functional development as to permit of precise determination of the regulatory changes in the arrangement of the fiber tracts and correlation centers by comparison with normal larvae of corresponding ages. This can be accomplished with considerable completeness by the use of the silver-impregnation methods of Cajal and Bielschowsky. Normal specimens of various ages up to adult are already available in the collections of Coghill, McKibben, Watkins, Burr, and others, and these are now in process of intensive study.

It is no accident that these and many other energetic workers in so diverse fields have converged their activities upon the development of the Amphibia. This material is very favorable for attack upon the most fundamental problems of growth and differentiation. In the cerebral hemispheres we find here the same morphological type as in mammals, but reduced to lowest terms, and the morphogenetic factors in the two cases doubtless have much in common. Studies on the early development of the human cerebral hemispheres made by Dr. Marion Hines Loeb and others in the laboratories of the University of Chicago have brought to light unexpected similarities with those of lower vertebrates, features which have in the past been overlooked just because the simpler paradigm was not taken into the reckoning.

The various researches to which reference has been made here and others on kindred topics which might have been mentioned have, for the most part, been independently planned and executed. They represent no formal collaboration, no elaborate machinery of organization. Men of diverse training and aptitudes have studied problems as they were presented, and their natural interests have drawn them together from different quarters. In the aggregate these investigations form an impressive

exhibit of successful accomplishment and still greater promise for the future.

As for this future, the best results will probably continue to follow from the unrestrained initiative of the individual workers. But, in view of the fact that this entire body of research does have so obvious an application to fundamental problems, and that the concentration of so diverse inquiries upon a single species gives broader promise than could be expected from any single line of investigation, it is probably expedient for those now working on Amblystoma to seek somewhat closer contacts with each other and more consciously so to direct their programs of research as to make the largest possible use of data supplied by their co-workers.

In particular, the experimental workers, who may not be in a position to carry to completion the very desirable (but very laborious) morphological studies necessary for the broadest interpretation of their results, may find it advantageous at times to seek conference on these questions. I refer especially to matters of internal structure, courses of fiber tracts, functional connections of correlation centers, etc., at definite ages, regarding which there is a large body of ascertained fact, much of which is as yet unpublished.

One of the first desiderata is an authoritative record of the chief characteristics of the nervous system at successive stages of development, arranged preferably by stages, as yet unpublished, as defined by Harrison, and these in correlation with known stages of physiological development—in short, a series of normal tables of the nervous system, based on the sequence of both structural and functional development. This enterprise it is hoped will soon be undertaken in the Yale laboratories under the direction of Doctor Burr, and will serve as a useful norm or datum of reference for comparison with the quantitative studies of growth of mammalian types now so actively prosecuted in several American laboratories.

An account of the plastic changes in the external form should follow, with pictures of the stages from models. The description of these form changes is, however, largely dependent for its value

upon the identification of the regions in correlation with adult structure and functional localization at successive ages. The data for such a correlation are still far from complete, but are accumulating, and it is hoped that the time is not far distant when such a description can be written, with more or less of correlation of changes in external form with corresponding changes in behavior pattern and in histological differentiation internally. More detailed studies of the development of reflex patterns from early larval to adult stages are necessary for the consummation of the program.

March 2, 1922

ADDENDUM

At the time when these proof sheets pass to the press (April 11, 1922) it can be stated that the studies referred to in the last sentence above are in process. Under a research program organized jointly by the University of Kansas and the University of Chicago, Doctor Coghill and Mr. Watkins have this season already studied intensively the early development of the reflex pattern in upwards of 100 individual larvae of Amblystoma and the work is now continuing to include still other series of specimens. Many hundreds of specimens of tested physiological age have been fixed for future histological study.

LITERATURE CITED

ALLEN, BENNET M. 1916 The results of extirpation of the anterior lobe of the hypophysis and of the thyroid of Rana pipiens larva. Science, n. s., vol. 44, pp. 755–757.

1920 Experiments in the transplantation of the hypophysis of adult Rana pipiens to tadpole. Science, n. s., vol. 52, pp. 274–276.

BELLAMY, A. W. 1919 Differential susceptibility as a basis for modification and control of early development in the frog. Biol. Bull., vol. 37, pp. 312–361.

BINDEWALD, CARL A. E. 1914 Das Vorderhirn von Amblystoma mexicanum. Arch. f. mikr. Anat., Bd. 84, S. 1–74.

BOK, S. T. 1915 Die Entwicklung der Hirnnerven und ihrer zentralen Bahnen. Die stimulogene Fibrillation. Folia Neurobiol., Bd. 9, S. 475–565.

1915 a Stimulogenous fibrillation as the cause of the structure of the nervous system. Psychiatr. en neurol. Bladen, pp. 1–16.

1917 The development of reflexes and reflex tracts. I. The reflex circle. Psychiat. en neurol. Bladen, pp. 281–303.

Burr, H. S. 1916 The effects of the removal of the nasal pits in Amblystoma embryos. Jour. Exp. Zoöl., vol. 20, pp. 27–57.

1916 a Regeneration in the brain of Amblystoma. I. The forebrain. Jour. Comp. Neur., vol. 26, pp. 203–211.

1920 The transplantation of the cerebral hemispheres of Amblystoma. Jour. Exp. Zoöl., vol. 30, pp. 159–169.

Child, C. M. 1921 The origin and development of the nervous system. Chicago.

Coghill, G. E. 1902 The cranial nerves of Amblystoma tigrinum. Jour. Comp. Neur., vol. 12, pp. 205–289.

1909 The reactions to tactile stimuli and the development of the swimming movement in embryos of Diemyctylus torosus Eschscholtz. Jour. Comp. Neur., vol. 19, pp. 83–105.

1913 The primary ventral roots and somatic motor column of Amblystoma. Jour. Comp. Neur., vol. 23, pp. 121–143.

1914 Correlated anatomical and physiological studies on the growth of the nervous system of Amphibia. I. The afferent system of the trunk of Amblystoma. Jour. Comp. Neur., vol. 24, pp. 161–233.

1916 The same. II. The afferent system of the head of Amblystoma. Jour. Comp. Neur., vol. 26, pp. 247–340.

Cope, E. D. 1887 The origin of the fittest. New York.

Griggs, Leland 1910 Early stages in the development of the central nervous system of Amblystoma punctatum. Jour. Morph., vol. 21, pp. 425–483.

Herrick, C. Judson 1910 The morphology of the forebrain in Amphibia and Reptilia. Jour. Comp. Neur., vol. 20, pp. 413–547.

1914 The cerebellum of Necturus and other urodele Amphibia. Jour. Comp. Neur., vol. 24, pp. 1–29.

1914 a The medulla oblongata of larval Amblystoma. Jour. Comp. Neur., vol. 24, pp. 343–427.

1917 The internal structure of the midbrain and thalamus of Necturus. Jour. Comp. Neur., vol. 28, pp. 215–348.

1921 A sketch of the origin of the cerebral hemispheres. Jour. Comp. Neur., vol. 32, pp. 429–454.

1921 a The connections of the vomeronasal nerve, accessory olfactory bulb and amygdala in Amphibia. Jour. Comp. Neur., vol. 33, pp. 213–280.

Herrick, C. Judson, and Coghill, G. E. 1915 The development of reflex mechanisms in Amblystoma. Jour. Comp. Neur., vol. 25, pp. 65–85.

Ingvar, Sven 1920 Reaction of cells to the galvanic current in tissue cultures. Proc. Soc. Exp. Biol. and Med., vol. 17, pp. 198–199.

Kappers, C. U. Ariëns 1917 Further contributions on neurobiotaxis. IX. An attempt to compare the phenomena of neurobiotaxis with other phenomena of taxis and tropism. The dynamic polarization of the neuron. Jour. Comp. Neur., vol. 27, pp. 261–298.

1921 On structural laws in the nervous system. The principles of neurobiotaxis. Brain, vol. 44, pp. 125–149.

Kingsbury, B. F. 1895 On the brain of Necturus maculatus. Jour. Comp. Neur., vol. 5, pp. 139–205.

LANDACRE, F. L. 1921 The fate of the neural crest in the head of the urodeles. Jour. Comp. Neur., vol. 33, pp. 1–43.

LARSELL, O. 1920 The cerebellum of Amblystoma. Jour. Comp. Neur., vol. 31, pp. 259–282.

LILLIE, R. S. 1919 Nervous and other forms of protoplasmic transmission. Sci. Mo. (May and June).

PATON, S. 1907 The reactions of the vertebrate embryo to stimulation and the associated changes in the nervous system. Mitt. Zool. Station zu Neapel, Bd. 18, S. 535–581.

RÖTHIG, PAUL 1911 Zellanordnungen und Faserzüge im Vorderhirn von Siren lacertina. Anhang zu Abhandl. kön. Preuss. Akad. der Wissen., Berlin, S. 1–23.

1911 a Beiträge zum Studium des Zentralnervensystems der Wirbeltiere. 4. Der markhaltigen Faserzüge im Vorderhirn von Necturus maculatus. Arch. f. Anat. u. Physiol. Anat. Abt., pp. 48–56.

1912 The same. 5. Die Zellanordnungen im Vorderhirn der Amphibien, mit besonderer Berücksichtigung der Septumkerne und ihr Vergleich mit den Verhältnissen bei Testudo und Lacerta. Kon. Akad. Wetensch. te Amsterdam (2 Sectie), Deel 17, pp. 1–23.

SMITH, P. E. 1920 The pigmentary, growth and endocrine disturbances induced in the anuran tadpole by the early ablation of the pars buccalis of the hypophysis. Amer. Anat. Mem., no. 11.

Resumen por el autor, Austin T. Moore.

Una conexión anómala de los músculos piriforme y biceps del fémur.

Durante una disección de un varón negro bien desarrollado, de unos treinta y siete años de edad, el autor encontró un músculo distinto biventral que se extendía desde la pelvis llegando hasta el biceps femoral, en la unión de sus cabezas larga y corta. El músculo se originaba en forma de un tracto separado de las fibras antero-inferiores del músculo piriforme, pasando a través del gran foramen ciático y procediendo distalmente y lateralmente sobre la superficie posterior de la tibia por debajo del glúteo máximo. Un poco antes de alcanzar el borde inferior de este musculo se convertía en tendínoso, continuando de este modo hasta el nivel del orígen superior de la cabeza corta del beceps. En este punto el musculo descrito volvía a transformarse en carnoso terminando el en biceps femoral, en la unión de sus cabezas corta y larga.

Translation by José F. Nonidez
Cornell University Medical College, N. Y.

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, APRIL 17

AN ANOMALOUS CONNECTION OF THE PIRIFORMIS AND BICEPS FEMORIS MUSCLES

AUSTIN T. MOORE

Department of Anatomy, Medical College of the State of South Carolina

ONE FIGURE

During the course of dissecting a well-developed negro, apparently between thirty-five and forty years of age, there was found a distinct double-bellied muscular anomaly in association with the piriformis and biceps femoris muscles, extending from the origin of the piriformis to the junction of the long head of the biceps with its short head. No other muscular abnormalities were observed.

The muscle arose as a detached slip of the lower anterior fibers of the piriformis, and lay on the anterior surface of this muscle near its lower border in the first part of its course. Passing out of the greater sciatic foramen, it proceeded distally and laterally in the posterior aspect of the thigh under cover of the gluteus maximus. Just before reaching the lower border of this muscle it became tendinous. This tendon, of approximately 2 mm. in diameter, continued underneath the long head of the biceps till it reached the level of the upper origin of the short head of the biceps. Here the muscle again became fleshy and continued to the junction of the long and short heads of the biceps, terminating in their common tendon of insertion into the tibia and fibula. The general appearances and relations are diagrammatically shown in the accompanying figure.

The superior belly derived its nerve supply from a small branch of the great sciatic nerve. The inferior was supplied by two small twigs from the branch of the nerve to the hamstring muscles that supplied the short head of the biceps.

The blood supply was derived from two sources. A branch of the inferior gluteal artery supplied the superior belly, while the inferior belly was supplied by twigs from the third and fourth perforating branches of the profunda femoris artery.

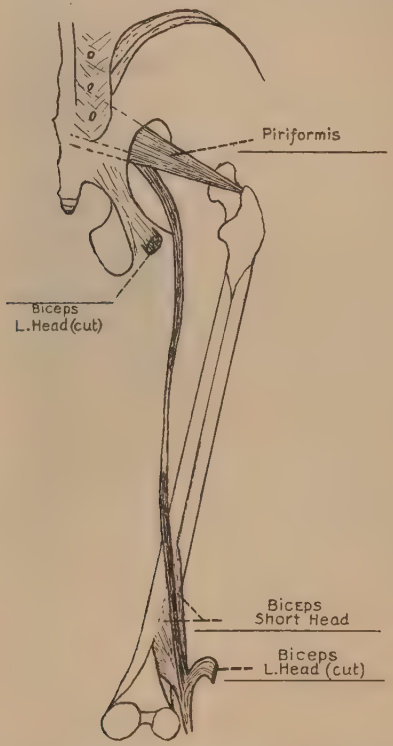


Fig. 1 Sketch of a double-bellied anomalous muscle extending from the piriformis to the junction of the long and short heads of the biceps. From an adult negro.

In the literature accessible to me, no anomaly identical with this has been found, although several observers have reported muscular fascicles, associated with the biceps, with which the muscle herein reported has some common resemblances.

Wood (1) reports a muscle arising from the under surface of the gluteus maximus and inserted into the long head of the biceps.

Halliburton (2) describes a muscle having a contiguous origin with the long head of the biceps, but inserted into the gastrocnemius.

Testut (3) reports a double origin of the biceps, the abnormal head arising from the coccyx.

LeDouble (4) reports a muscle having a common origin with the biceps, but inserted into the tendo calcaneus. He also states that Macalister has reported a muscle arising from the outside of the sacrum and that Soemmering has reported one arising from the pelvis, but terminating at the ischium.

LeDouble, from consideration of the abnormalities of the biceps observed by himself and also from the reports of othes, divides them into two classes: First, those having a pelvic origin terminate in the long portion of the biceps; second, those having an origin in the posterior region of the thigh terminate in the short portion of the biceps. It is seen that the muscle here reported falls in neither of these classes.

BIBLIOGRAPHY

1 Wood 1867 Proc. Roy. Soc. London, vol. 15, p. 540.
2 Halliburton 1881 Journ. Anat. and Phys., vol. 15, p. 296.
3 Testut 1884 Les anomalies musculaires chez l'homme. Paris, p. 630–631.
4 LeDouble 1897 Variations du systeme musculaire de l'homme. Paris, T. 2, p. 281.

Resumen por el autor, O. Ishii.

Observaciones sobre el ciclo sexual de la rata albina.

En el presente trabajo se discuten los siguientes puntos: 1)¿Sigue la preñez a la primera copulación de la rata? 2) Duración del periodo de gestación. 3) Influencia de la alimentación sobre el número de individuos de la cría. 4) Condición de la rata en vías de crecimento después del nacimiento. 5) La época del primer estro general en la rata. 6) Signos del primer estro general. 7) Distinción entre el estro general y el periodo de ardor sexual propiamente dicho. El autor had encontrado que el método de los frotes no permite una distinción entre estas dos condiciones. 8) Duración, época de la aparición y signos del periodo de ardor sexual propiamente dicho en la rata. 9) Periodo diéstrico. 10) ¿Ejerce la copulación estéril influencia sobre el ciclo sexual de la rata?

Translation by José F. Nonidez
Cornell University Medical College, N. Y.

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, MAY 1

OBSERVATIONS ON THE SEXUAL CYCLE OF THE WHITE RAT

O. ISHII

Department of Comparative Pathology, Washington University, St. Louis

1. Normal pregnancy does not usually result from the first copulation, but only when copulation has taken place more than once does the female become pregnant. For this purpose it is, furthermore, necessary that copulation with a healthy male take place at the actual period of heat of the female rat. On very rare occasions, however, pregnancy may result from a single copulation. The same I found also to hold good in the case of guinea-pigs.

2. In the majority of cases the duration of the gestation period of the rat is $21\frac{1}{2}$ to $22\frac{1}{2}$ days. My observations on this point confirm those of Stotsenburg (4). However, in some exceptional cases I have found the period of pregnancy to last 23 days.

3. To determine the influence of nourishment on the size of the litter, I observed two sets of ordinary stock rats. *a*) In the first set they were fed grain, green vegetables, and milk once a day; *b*) in the second set they were fed table scraps three times a day. This material was fresh and in good condition every time. In both sets special care was taken to keep the cages dry, since wet cages disturb the health of the animals. In the first set the number in the litter averaged from six to nine and sometimes reached ten or eleven; in the second set the average was greater, namely, from nine to twelve and sometimes more. Stotsenburg (4) also found that feeding with table scraps causes the size of the litter to be larger than a diet of bread and milk.

4. The weight of the young rat at birth was on the average from 4 to 5 grams; this agrees with the statements of various authors. In addition, I have observed that the hair begins to grow about seven to eight days after birth, when it has the

appearance of very fine fur visible to the naked eye. In healthy rats the eyes open about on the fourteenth or fifteenth day.

5. The time of the first general oestrus in the rat. The statements of various authors vary as to the age at which the first general oestrus occurs in the rat.[1] Thus Long and Evans (3) state that on the average it takes place at the age of 70 to 90 days and in some cases the date may vary between 45 and 120 days, while Donaldson reports that breeding begins at the age of about three months. Recently H. M. Evans and K. L. Bishop stated that the first oestrus begins on the average at the age of 47 days and that the dioestrous period lasts on the average of 5.4 days. This holds good if the animals are fed with a standard diet consisting of whole wheat, whole-milk powder, casein, salts, and 5 per cent butterfat. According to my statistics, in rats which are fed on table scraps the opening of the vagina or the first menstruation occurs in normal animals weighing from 60 to 80 grams at an age of 32 to 40 days; sometimes they may, however, be as old as 45 days.

6. Signs of the first general oestrus. Up to the time of the first general oestrous period the vaginal lips are closed with a thin membrane. Gradually the membrane begins to rupture. The maximum enlargement in the opening is reached five to seven days after the onset of the general oestrus. During this period there is no appreciable amount of moist secretion visible at the vaginal orifice; only a dry material is found. This is followed by a stage in which the secretion becomes more copious and serous or watery in character as it is found at the ordinary oestrous period. Now, the vaginal lips are slightly swollen and glistening. In some cases the rat comes into actual heat in the first general oestrous period, but often copulation does not take place at that time. In other words, the animal has not yet reached the condition of heat proper. After the onset of the second general oestrous period real heat occurs in every rat. According to my previous

[1] We shall distinguish between general oestrus and heat proper. By the former we understand the whole period during which an increased secretion is visible at the vaginal orifice, while the latter is only the period in which the female is ready for copulation. The second period forms a part of the first one.

observations, conditions are analogous in the guinea-pig. Here also the first general oestrus is prolonged.

7. Distinction between heat and the general oestrus in the rat. Some authors do not distinguish between the period of general oestrus, which is characterized by secretion, and the heat proper. When the rat comes into heat, she becomes somewhat more playful and holds up her tail and the external portion of the vagina. At this time she is ready for copulation, if a male rat approaches her and attaches himself to her back. Whenever she is not ready for copulation, the real period of heat is not present. The heat represents one period in the general oestrous period. Long and Evans have stated that they can determine the heat period by means of the vaginal-smear method of Stockard and Papanicolaou (5). Contrary to this conclusion, we do not find that the smear method enables us to distinguish between heat proper and the general oestrous period.

8. The heat period proper in the rat. This period has an average uninterrupted duration of from four to six hours. During the greater part of the period there is a secretion visible on the external vagina. Towards the end of this heat period, however, the secretion is either lacking altogether or its amount is very much decreased. I have found this to hold equally good in the case of the guinea-pig. In one exceptional case I have, however, noticed that the heat period proper lasted continuously for eight hours. Another important point is that in most cases the rat enters into the heat period proper usually about midnight, or after 9 o'clock; only in rare cases does this period take place in the daytime.

Duration of the dioestrous period in the rat

NUMBER OF ANIMAL	AGE AT TIME FIRST OESTRUS	1ST	2ND	3RD	4TH	5TH	6TH	7TH	8TH	9TH	10TH	11TH	12TH	13TH	14TH
	days														
1	33	11	18	5	5	7	3	8	5	3	6	7	4	5	8
2	35	4	5	13	10	5	9	5	20	3	4	2	4	2	4
3	43	5	5	12	6	9	3	5	4	3	2	5	4	3	6
4	45	4	4	12	10	15	4	9	5	3	5	11	2	7	5

The figures signify the number of days between two successive oestrous periods.

9. Dioestrous period of the rat. According to Long and Evans (3), the rat shows a very peculiar dioestrous period. The length of this period varies in each individual case. We likewise obtained a marked variation in the length of the dioestrous period.

According to the data of this table, the longest duration of the dioestrous period was twenty days; the shortest two days; furthermore, in each individual the duration varies in different periods. There is some reason for assuming that in case the dioestrous period lasts only two days heat proper did not develop inasmuch as the female did not accept the male, although vaginal secretion was present. True heat was, however, found in those rats in which the dioestrous period lasted three or more days.

10. Does sterile copulation exert an influence on the sexual cycle in the rat? According to Long and Evans (3), a sterile copulation in the rat leads to a lengthening in the subsequent dioestrous periods. Some years ago I had made a similar suggestion; however, actual observation of guinea-pigs, in which the animals after copulation apparently did not develop pregnancy, did not reveal any difference in the duration of the sexual cycle between these and normal animals which had not copulated. My recent observations show that the same holds good in the case of the rat. Here also sterile copulation has no influence on the sexual cycle.

LITERATURE CITED

1 Donaldson, H. H. 1915 The rat. Philadelphia.
2 Ishii, O. 1920 Biol. Bull., vol. 18, p. 237.
3 Long, A. J., and Evans, H. M. 1920 Anat. Rec., vol. 18, p. 241.
4 Stotsenburg, J. M. 1915 Cited from Donaldson, H. H., The rat. Philadelphia, pp. 21 and 23.
5 Stockard, C. R., and Papanicolaou, G. N. 1917 Am. Jour. Anat., vol. 22, p. 225.

Resumen por el autor, Howard H. Bell

Páncreas horizontal y vertical en asociación con otras anomalías del desarrollo.

El primer ejemplar descrito posee un proceso horizontal de 51 mm. de longitud, semejante al páncreas normal, un proceso vertical de 28 mm. de longitud, que pasa hacia abajo deslizándose sobre la superficie mesial del duodeno, y un proceso anular alrededor de este último; todos estos procesos se reunen en el sitio ocupado por la cabeza del páncreas normal. El proceso anular presenta un conducto separado. El tabique interventricular del corazón es defectuoso por debajo de la parte membranosa. El agujero oval y el conducto de Botal son permeables. En el lado derecho existe una hernia umbilical y otra inguinal. El divertículo de Meckel persiste.

En el segundo ejemplar ha hallado el autor: Un divertículo de la pared posterior del estómago, situado debajo del orificio esofágico y unido con las meníngeas a través de las hendiduras vertebrales. El intestino delgado abandona la pared posterior del estómago en la línea media, debajo de este divertículo. En el extreme pilórico del estómago existe otro divertículo, orígen del hígado y páncreas. El páncreas posee un proceso horizontal de 65 mm. de longitud, el cual cruza la pared anterior del estómago, y un proceso vertical de 34 mm. que pasa hacia abajo. El primero posee un conducto independiente que se abre en el divertículo a una distancia de 5 mm. del otro orificio. Resumen de las anomalías asociades: Espina bífida posterior con mielocistomeningocele; espina bífida anterior; puente intraespinal, médula oblongada y cerebelo rudimentario; ausencia del tentorio cerebelar; ausencia de la isla de Reil; ausencia de glándula pineal, acueducto de Silvio y cuerpos cuadrigéminos; anormalidad en la circulación cardiaca, hígado, estómago y páncreas; defectos en el lado izquierdo del diafragma; ausencia del omento mayor, divertículo de Meckel bifurcado; disposición anormal de los intestinos grueso y delgado; testículos no descendidos; talipes varus.

Translation by José F. Nonidez
Cornell University Medical College, N. Y.

AUTHOR'S ABSTRACT OF THIS PAPER ISSUED
BY THE BIBLIOGRAPHIC SERVICE, APRIL 7

HORIZONTAL AND VERTICAL PANCREAS, IN ASSOCIATION WITH OTHER DEVELOPMENTAL ABNORMALITIES

HOWARD H. BELL

Pathological Laboratory, Washington University School of Medicine, St. Louis, Missouri

TWO FIGURES

This type of abnormality in the development of the pancreas was described by Carnot.[1] The pancreas in his case possessed a head, a horizontal process 10 cm. long, resembling the body and tail of the normal pancreas, and a vertical process 12 cm. long extending downward from the head along the duodenum. Neve[2] mentioned extra tail lobes as an instance of reversion to a lower type. I have failed to find further reference in the literature to pancreas with horizontal and vertical processes, yet I have found two instances of this anomaly.

The first instance occurred in a well-nourished white male child, four months old. The cause of death was bronchopneumonia and extensive atelectasis.

The pancreas completely encircled the second part of the duodenum and possessed a horizontal and a vertical process. The band of pancreatic tissue encircling the duodenum was 10 mm. wide anteriorly, and 6 mm. wide posteriorly. The horizontal process resembled the normal pancreas. It measured 51 mm. long and 11 mm. in the other dimensions. Along the upper border near the duodenum was a rounded enlargement 11 mm. across. The vertical process descended along the mesial surface of the second part of the duodenum and passed anterior to the transverse part. This process measured 28 mm. long and 9 mm. in the other dimensions. The two processes and the annular part joined at the site occupied by the head of the nor-

[1] Carnot. Maladies des glands salivaires. Paris, 1908.
[2] Neve. The Indian Medical Record, 1892, vol. 3, no. 3.

mal pancreas. The annular part encircled the duodenum from behind forward and was in apposition with pancreatic tissue anteriorly, but not continuous with it. The duodenum was slightly constricted at this point.

The common bile duct opened into the duodenum with the pancreatic duct from the horizontal and vertical processes. The annular part possessed an individual duct opening into the duodenum slightly above and posterior to the ampulla of Vater.

Other developmental abnormalities were present. The interventricular septum of the heart was defective below the membranous part. This defect measured 21 mm. vertically, and 11 mm. horizontally. The foramen ovale and ductus Botalli were pervious, but the openings were very small. There was a slight umbilical hernia and a small inguinal hernia on the right side. Meckel's diverticulum persisted and measured 5 cm. long.

The second anomaly occurred in association with anterior spina bifida and other abnormalities which will be described elsewhere.

The infant was still-born at term. The stomach was greatly dilated. The small intestine joined the posterior wall of the stomach in the midline of the body. It opened into the cavity of the stomach by a slit-like orifice guarded by a valve-like fold. From the point where the intestine met the stomach to the site of its gastric orifice, it lies beneath the gastric peritoneum (See Fig. 2). The gastric orifice of the intestine was 5.5 cm. from the pyloric end of the stomach. The pyloric end of the stomach had the form of a blind diverticulum into which the common bile duct opened. The horizontal and vertical pancreatic processes met upon this diverticulum. The diverticulum was about 1 cm. wide and 1.5 cm. long and ended in a blind rounded extremity.

The pancreas possessed a horizontal and a vertical process. The horizontal process extended across the anterior wall of the stomach and was loosely attached to it. It measured 65 mm. long, 9 mm. wide, and 4 mm. thick. The vertical process extended downward. Its lower extremity was slightly enlarged and was turned abruptly backwards. The upper part of this process measured 34 mm. long, 9 mm. wide and 4 mm. antero-

posteriorly. The lower part, which was enlarged and turned backwards, measured 12 mm. anteroposteriorly, 14 mm. vertically, and 5 mm. transversely. The horizontal and vertical processes were contiguous over the summit of the diverticulum.

There were two papillae with openings into the diverticulum, situated about 5 mm. apart. The duct from the vertical process led in conjunction with the common bile duct into the end of the diverticulum. The duct from the horizontal process opened into the superior wall of the diverticulum.

The relation of the pancreatic processes and associated organs to the stomach is shown in fig. 1.

Many abnormalities were associated with the second specimen. The liver was abnormal in shape. There was a funnel-shaped diverticulum from the posterior wall of the stomach below and posterior to the oesophageal opening, which was attached to the meninges through the anterior spina bifida. The relation of this opening to the stomach is shown in fig. 2.

A summary of associated abnormalities is as follows:

Posterior spina bifida with myelocystomeningocele
Anterior spina bifida
Intraspinal pons, medulla and rudimentary cerebellum
Absence of tentorium cerebelli
Accessory superior longitudinal fissure in right hemisphere
Absence of islands of Reil
Absence of pineal body, aqueduct of Sylvius and corpora quadrigemina
Abnormality of heart
Defect in diaphragm on left side
Abnormality of liver and stomach
Absence of greater omentum
Bifurcated Meckel's diverticulum
Abnormal arrangement of small and large intestines
Undescended testicles
Talipes varus.

Two related cases described by Graefe and Vesalius were mentioned by Mondière.[3] The one described by Graefe pos-

[3] Mondière. Archiv. gén. de Méd., 1836, 2d ser., T. 11.

sessed three pancreatic ducts, one of which opened into the stomach. Richeraud stated in his physiology that Vesalius described a case in which the ductus choledochus emptied into the stomach.

Aberrant pancreatic tissue has occurred in the wall of the stomach in several instances.[4]

The human pancreas develops from one posterior and one anterior bud; occasionally there are two anterior buds which soon fuse to form one. The posterior and anterior processes grow together to form the mature pancreas.[5]

The shape of the pancreas varies in different species. The pancreas of the ox and sheep is irregularly quadrilateral in form.[6] The pancreas of the horse is very irregular, although triangular in outline. The pancreas of the pig is elongated and situated transversely. The right portion has two lobes; the posterior lobe bends around the great mesenteric artery and the portal vein; the anterior one is pointed, extends downward and forward in the median plane and is attached in the portal fissure and to the duodenum. The left portion is prismatic and rests mainly on the left sac of the stomach, its left extremity being included between the left kidney and the dorsal end of the spleen. The pancreas of the dog is V-shaped, consisting of two long, narrow branches which meet at an acute angle. The right branch extends along the duodenum. The left branch is attached to the peritoneal surface of the stomach. In the cat the pancreas has two processes; one process extends along the duodenum and the other process extends along the stomach. The two processes are nearly at right angles to one another.[7]

[4] Opie, E. L. Disease of the pancreas. 1910. J. B. Lippincott Co., Philadelphia.

[5] Keith. Human Embryology. 1913. Edward Arnold, London.

[6] Sisson. Veterinary anatomy. 1910. W. B. Saunders Company, Philadelphia.

[7] Reighard and Jennings. Anatomy of the cat. 1910. Henry Holt & Co., New York.

The first specimen resembles the pancreas of the dog and cat in that it has a horizontal and a vertical process, although it has in addition an annular process. The position of the pancreatic ducts in this specimen would indicate that the annular part developed from posterior budding and the horizontal and vertical processes from anterior budding.

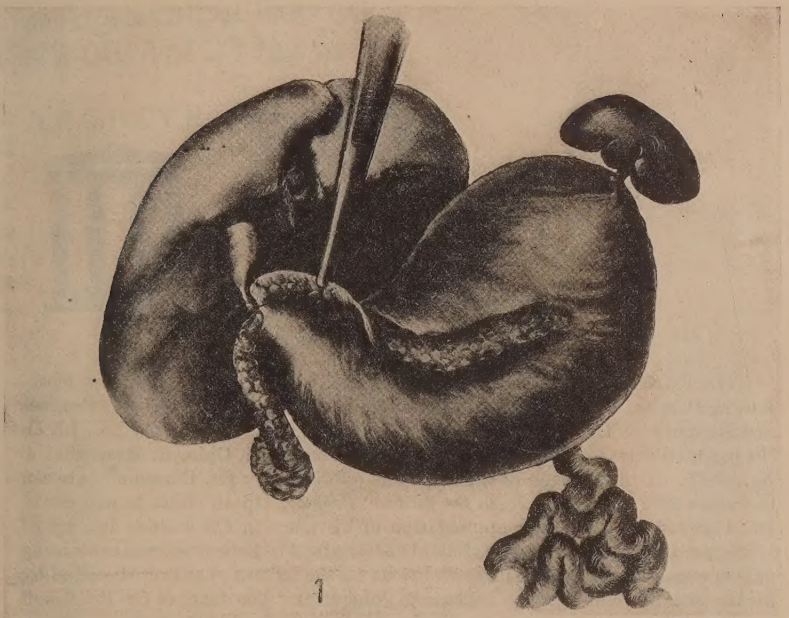
The second specimen was associated with many unusual abnormalities. The horizontal and vertical processes were in apposition on the summit of the gastric diverticulum, although no fusion had taken place.

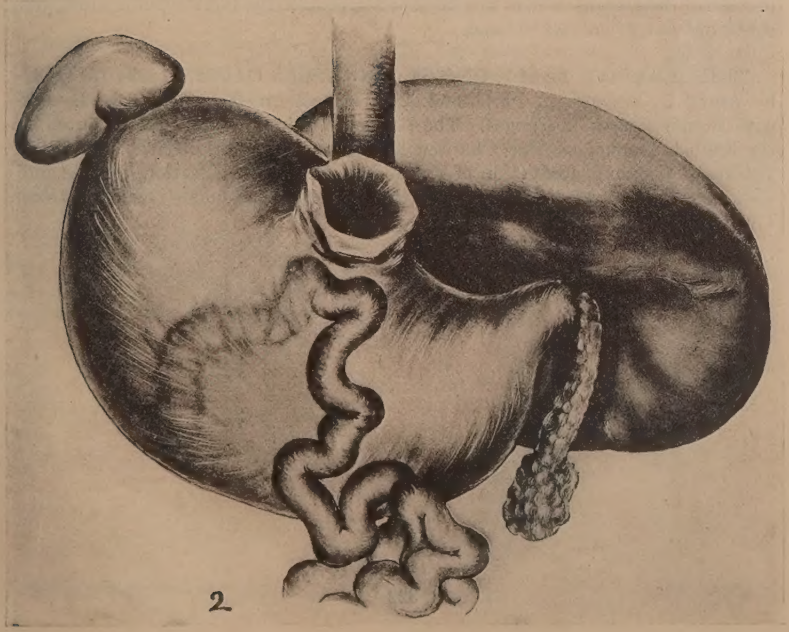
PLATE 1

EXPLANATION OF FIGURES

1 Drawing of anterior view of liver, stomach, pancreas and spleen. The liver is raised, and the right end of the horizontal pancreas is elevated with forceps, to show the relation of the liver, the horizontal and vertical pancreas to the diverticulum of the stomach.

2 Drawing of posterior view of organs. The liver is tilted forward. Below and posterior to the oesophagus is shown the diverticulum which was attached to the cleft vertebrae. Below this diverticulum the small intestine passes obliquely through the wall of the stomach and opens into it.


1


2.

BOOKS RECEIVED

(*Continued from first page*)

THE RANSOHOFF MEMORIAL VOLUME. A Collection of Papers representing Original Contributions to the Art and Science of Medicine by Colleagues and Students of Dr. Joseph Ransohoff, M.D., F.R.C.S. (Eng.), F.A.C.S., LL.D. 574 pages, illustrated, containing 57 papers. Cincinnati, Ohio, S. Rosenthal & Co. 1921. A list is given of the 44 papers published by Dr. Ransohoff between the years 1879 and 1920. *From the Editors' Preface.* In an effort to express to Dr. Joseph Ransohoff their appreciation of his place in the science and art of Medicine, a group of his former students determined to issue a volume containing papers consisting of original contributions to the advancement of Medicine by his students and colleagues. This was in June, 1920. The death of Dr. Ransohoff prevented the presentation of this book to him personally, but the publication was continued as a Memorial Volume.

THE RELATIVE VALUE OF THE PROCESSES CAUSING EVOLUTION by Arend L. Hagedoorn, Ph.D. and A. C. Hagedoorn—Vorstheuvel La Brand, with twenty figures, 294 pages. The Hague, Martinus Nijhoff, 1921, printed in the English language. The Chapter headings are: Introduction, Heredity, Variation, Crossing, Reduction of Variability, Mutation, Selection, Species and Varieties, The Law of Johannen, Evolution in Nature and under Domestication, The Status of Man.